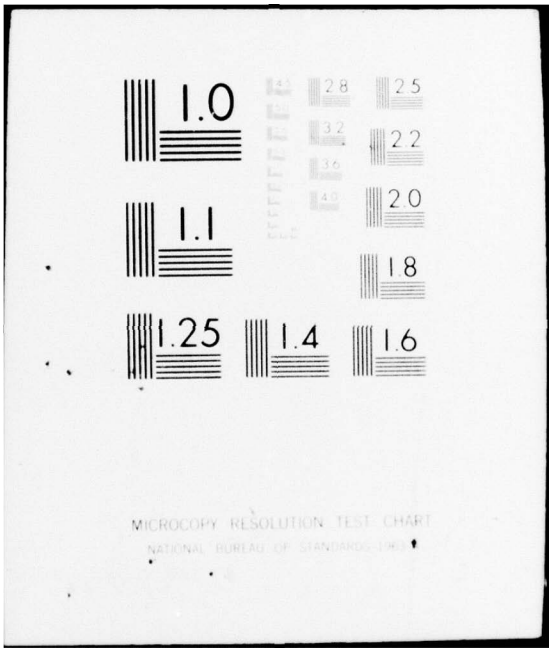
AD-A041 082 SPACE AND MISSILE TEST CENTER PATRICK AFB FLA DETACH--ETC F/G 20/5
LASER RANGING ON TEST 7683 (U)
MAR 77 J M KENNEDY
UNCLASSIFIED SAMTEC/DET 1-TR-77-03 NL

1 OF 1
AD A041082

END
DATE FILMED
7-77


1.0
1.1
1.25
1.4
1.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963

12

DET 1, SAMTEC-TR-77-03

LASER RANGING ON TEST 7688

Engineering Office
Range Measurements Laboratory
Patrick Air Force Base, Florida 32925

1 March 1977

Approved for Public Release
Distribution Unlimited

Prepared for

DETACHMENT 1, SPACE AND MISSILE TEST CENTER (AFSC)
PATRICK AIR FORCE BASE, FLORIDA 32925

LEGAL NOTICE

When U.S. Government drawings, specifications or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility, no obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

OTHER NOTICES

Do not return this copy. Retain or destroy.

This technical report has been reviewed and is approved for publication.

JOHN M. KENNEDY, Physicist
Trajectory Systems Branch
Range Measurements Laboratory
Engineering Office

WALTER HANSEN, Lt Col, USAF
Chief, Trajectory Systems Branch
Range Measurements Laboratory
Engineering Office

WALTER H. MANNING, JR., Chief
Range Measurements Laboratory
Engineering Office

FOR THE COMMANDER

HENRY D. KOENAN, Lt Col, USAF
Chief, Engineering Office

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Det 1, SAMTEC-TR-77-03	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: Laser Ranging on Test 7688	5. TYPE OF REPORT & PERIOD COVERED: Technical Memorandum; 18 Jan 77; 1903:29Z thru 1903:32Z
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): John M. Kennedy	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Det 1, SAMTEC/TOELT, Patrick AFB FL 32925	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: JON 58113
11. CONTROLLING OFFICE NAME AND ADDRESS: Det 1, SAMTEC/TOELT, Patrick AFB FL 32925	12. REPORT DATE: 1 March 1977
	13. NUMBER OF PAGES: 10
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

A

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

410 172

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Laser Ranging
Launch Support Metrics
Optical Tracking
ON-AXIS

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report presents the results of a test of the Laser Ranging system against the launch of a Trident missile coated with a band of reflective paint. Four consecutive laser "hits" at one second intervals were recorded and compared favorably, metrically, to the "Best Estimate of Trajectory" for this launch.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

TABLE OF CONTENTS

LASER RANGING ON TEST 7688

1. PURPOSE AND SUMMARY

The Range Measurements Laboratory has been involved in the development of advanced pointing and tracking systems since the inception of the laboratory. The RAMLAS (Range Measurements Lab Laser System) is the latest pointing and tracking system developed under a joint agreement between the AFETR and Goddard Space Flight Center, NASA, to provide ranging information on the GEOS-C satellite.

The RAMLAS is a ranging instrument with a 5 nanosecond pulse of approximately 500 millijoules. Because of this low radiated power, the system functions more effectively against targets with laser retro-reflectors such as corner cubes or special paint. During the past year, personnel within RML and the Naval Ordnance Test Unit (NOTU) have been jointly seeking to have a band of retro-reflective paint placed around the equipment stage of all C-2, C-3, and C-4 missiles which were to be launched from the AFETR and its environs. The C-4 launch of 18 Jan 77 was the first launch to carry the laser reflective paint. Figure 1 is an artist's concept of the Trident with the band of the laser reflective paint.

Data was obtained on four consecutive hits during the interval 1903:29-1903:32 or approximately T+34 to T+37. The range data was very consistent during this interval and when compared with the Best Estimate of Trajectory (BET) yields a mean value of the four data points of 4.25 ft. (Data is presented in Table 1.)

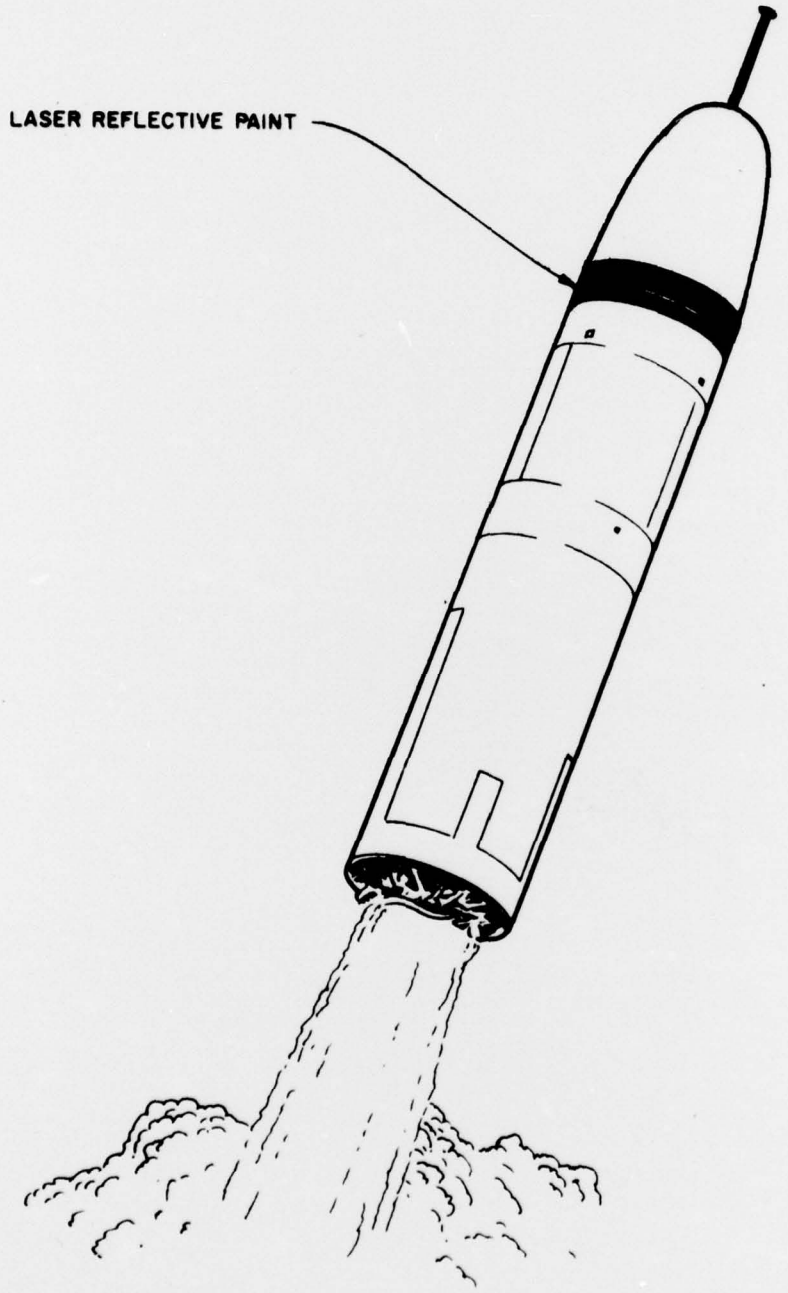


FIGURE 1

Trident with Reflective Paint

As stated in previous reports, there is currently no means of driving the RAMLAS on objects under powered flight utilizing the ON-AXIS tracking and pointing technique. As in previous tests, the mount was pointed by manual control while observing the launch vehicle in the 7" aperture boresight telescope and manually centering the target in the field of view. The range gate of the LASER RANGER was computer controlled. The gate was generated from the range obtained from the Acquisition Bus and was nominally set 10 μsec wide. The angle data from the Acquisition Bus is also listed as is the raw uncorrected angle information from the RAMLAS encoders. The system delay for this test was obtained in pre-cal and post-cal measurements and was consistent at 58 nanoseconds.

2. DATA

The following metric information was obtained on Test 7688 from the Range Measurements Lab Laser System. The location of the RAMLAS with respect to the WGS-72 ellipsoid is as follows:

Longitude	279.39413011
Latitude	28.2279195
Height	19.890 meters

The RAMLAS system delay for this test was 58 nanoseconds.

The speed of light used to convert nanoseconds to ft. was 9.833055640 x 10^8 ft/sec. The correction for range error due to refraction at the Ruby wavelength was m = 1.000270.

Table 1 presents the raw and corrected RAMLAS data, the BET (Best Estimate of the Trajectory) range, translated to the RAMLAS coordinates, and the difference between the two ranges.

TABLE 1

LASER RANGE VS BET RANGE

Time	Time of Flight Nanoseconds	Range Feet Corrected for Refraction and System Delay	BET Range FT Translated to Laser Ranger	Δ FT LR-BET
1903:29	164676.9	80935	80932	3
:30	166143.4	81656	81660	-4
:31	167739.9	82441	82450	-9
:32	169523.6	83318	83319	-1

Table 2 presents the angle and range data from the Acquisition Bus, translated to the RAMLAS site and the angle and range data from the RAMLAS. The RAMLAS range information is corrected data. The RAMLAS angle data is raw encoder data at the time of the range measurement and is not corrected for refraction, mislevel, droop, nonorth, etc.

TABLE 2

DESIGNATE (AC BUS) VS RAMLAS

Time	Designate (AC Bus)			RAMLAS		
	Range	AZ	EL	Range	AZ	EL
1903:29	82380	16.6°	13.4°	80935	15.9°	12.4°
:30	83250	17.2°	14.3°	81656	16.5°	13.3°
:31	84069	18.1°	15.4°	82441	17.1°	14.1°
:32	85032	18.9°	16.3°	83318	17.7°	14.9°

Table 3 displays the differences between the Acquisition Bus and the RAMLAS.

TABLE 3

Time	Azimuth (degrees)	Elevation (degrees)	Range Ft
1903:29	+0.7	+1.0	1445
1903:30	+0.7	+1.0	1594
1903:31	+1.0	+1.3	1628
1903:32	+1.2	+1.4	1714

3. THE LASER SYSTEM

3.1 Basic Information:

The Range Measurements Laboratory Laser System (RAMLAS) has been in an operational status as a GEOS-C ranger for almost two years. It is a bistatic system. The laser pulse is transmitted through a 6" aperture Tropel telescope and the return energy is collected through a 24" aperture Newtonian telescope. This system has been providing NASA with range information as part of the GEOS-C experiment. The range accuracy for GEOS-C measurements is in the neighborhood of 10 cm. The consistency of measurements from a static boresight source is approximately 3 cm.

3.2 Tracking:

The tracking system for the orbital case (i.e., GEOS-C) is the basic ON-AXIS Open Loop. The RML 0.13 radar is the primary sensor which provides the pointing information. The ON-AXIS program that is currently used does not have a powered flight capability and the RAMLAS must be positioned manually on powered flight targets.

3.3 Hardware and Specifications:

The transmitter specifications are as follows:

The transmitter is a Q-Switch Ruby Laser (6943A).

The transmitted pulse length is 5 nanoseconds.

The pulse repetition frequency is 1 pps.

The beam width is approximately 40 arc seconds.

The laser power is rated at 500 milli-joules.

The receiver specifications are as follows:

The basic receiver instrument is a 24" aperature Newtonian telescope.

The receiver is a gated 14 stage photomultiplier.

The range machine is by NANOFAST and is capable of variable range gates with computer and manual control.

The transient digitizer provides a real time readout of the pulse as transmitted and received.

The output of the nanofast is recorded on mag tape for post test refinement.

4. CONCLUSIONS AND RECOMMENDATIONS

We conclude that:

a. The ability to provide highly accurate laser ranging data has been demonstrated on both GEOS-C and this Trident launch.

b. The data could be significantly improved if precision angle data were associated with the measurements.

c. The present manual positioning technique, though superior to the acquisition bus, is far from optimal and is a source of the low data yield.

d. The low data yield because of the 1 PPS laser rate must be improved if velocity and acceleration information is to be extracted.

We recommend that:

a. To improve the metric measurement capability for quality and quantity, the RAMLAS system should be upgraded with a higher PRF laser (50 to 100 pps) and an angle track capability.

b. In conjunction with the system hardware upgrading, that a powered flight tracking capability be initiated for the RAMLAS.

Project Implementation Plans (PIPs) for the development of a Laser Radar and for Power Flight Development have been formulated by the Range Measurements Laboratory and are available upon request.